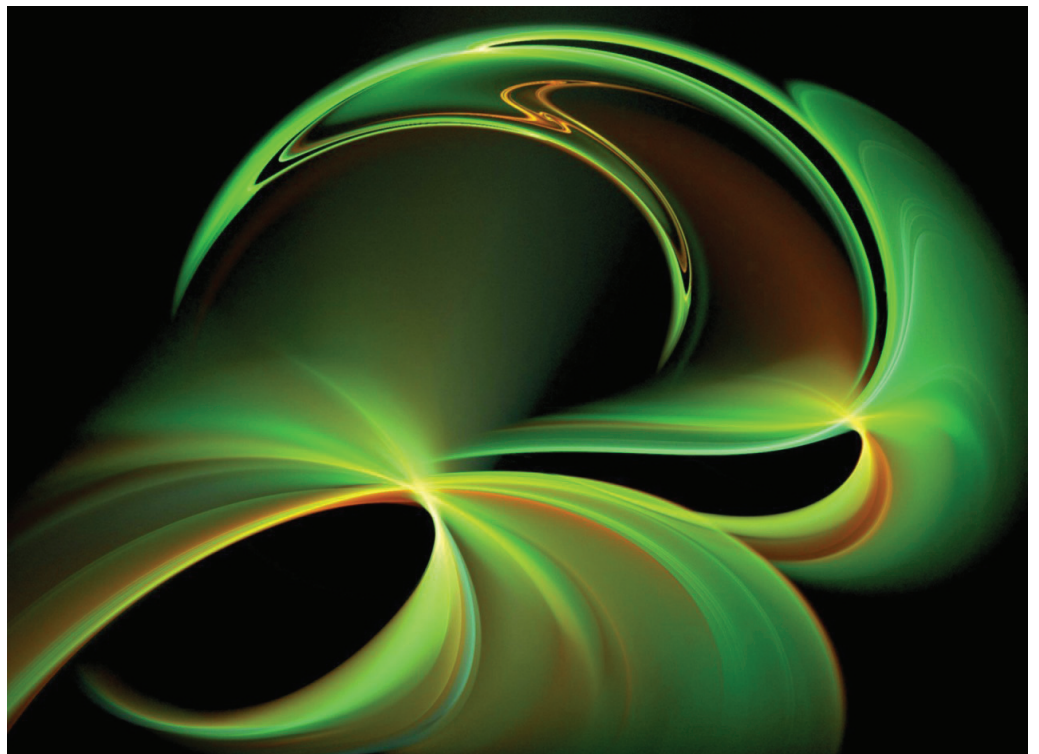


# Flows

Bobby Astrich and Briana Walters



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## Flows

Bobby Astrich, Briana Walters

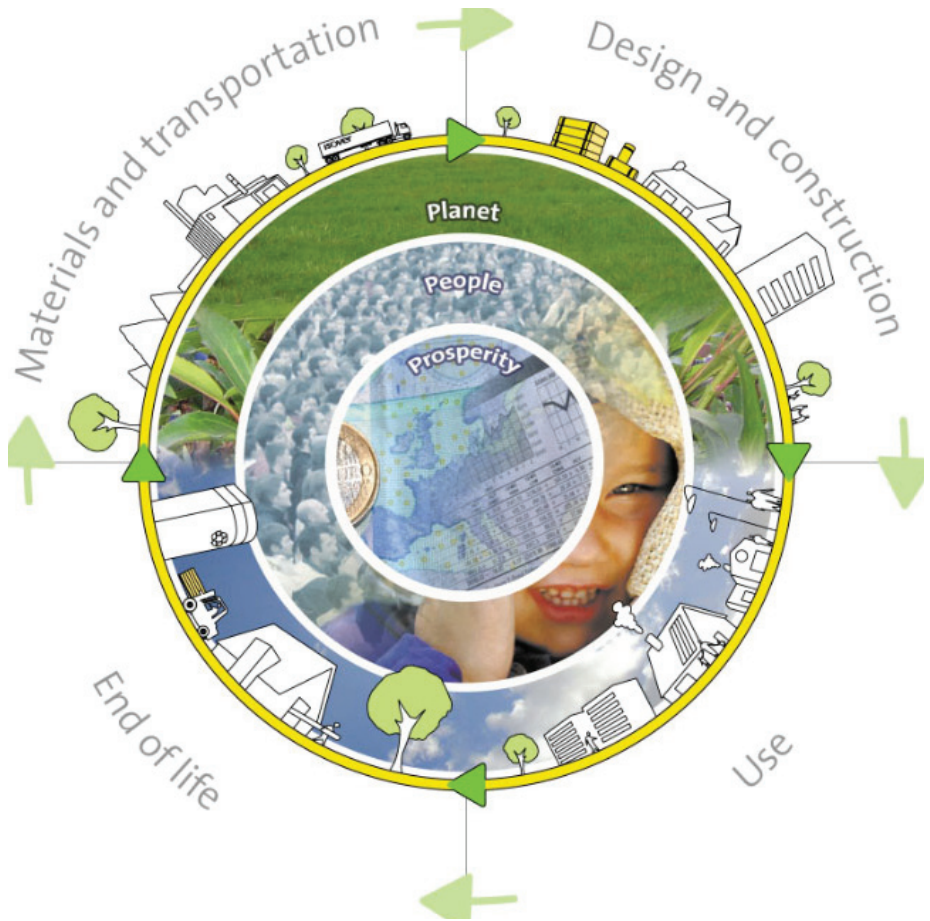


Fig. 01 Flows

Architecture is generally interpreted as a sequence of static spaces that can be analyzed with regard to a limitless list of design criteria. However, to really understand a building, and especially with an eye towards sustainability, architecture must be recognized as a series of overlapping processes and flows that all contribute to the creation, use, and disassembly of said architecture. There are five primary flows that every building can be examined through: raw materials, water, energy, organisms, and information. These primary flows then result in secondary flows such as waste, emissions, and money.

### Primary Flows

#### *Raw Materials*

In order to become useful products, raw materials must undergo either a linear or cyclical process. The major components of both processes begin with raw material extraction and transportation for processing. The processed materials are then used for tool and machinery production which in turn are used to make finished products. These products are then used and maintained until they reach the end of their life cycle. There, the linear process takes the products to a landfill while the

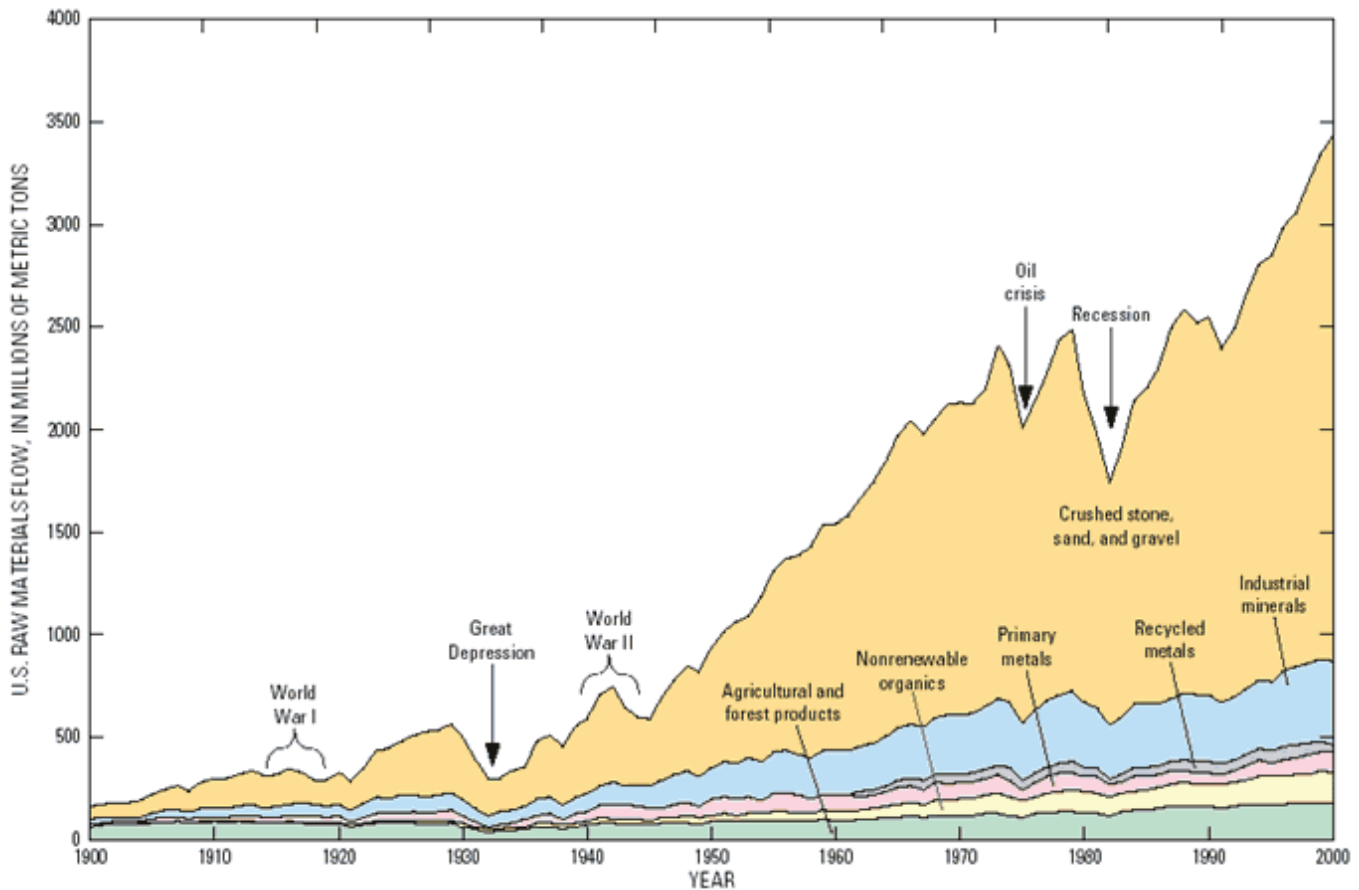


Fig. 02 Usage of raw materials in the US from 1900 to 2000

cyclical process recycles the product, thus generating another use cycle for any given material.

The flow of steel production is an example of this type of flow. Iron ores, such as hematite, limonite, taconite, magnetite are mined and then shipped to a smelter. There, the raw materials undergo a process called "beneficiation" where the ores are crushed and screened and shaped into pellets for shipping to a blast furnace. In the blast furnace, the iron ore is combined with coke (a substance made up of 90% carbon) and either limestone or burnt lime to create pig iron. After that, carbon is

added to produce steel. In order to create different steel properties, iron can be combined with other metals. For example, phosphorous in large quantities reduces ductility while silicon increases the strength and toughness without greatly reducing ductility. <sup>1</sup>

Once in its finish form, steel is rolled into different shapes and used for construction. At the end of its use as a building material, steel is usually recycled. There are two types of steel recycling methods, the basic oxygen furnace and the electric arc furnace. The basic oxygen furnace uses 25-35% old steel to make

new. The electric arc furnace uses more than 80% old steel, producing products whose major required characteristic is strength.

The recyclability of steel is a major reason why many people view steel as a sustainable material. Recycled steel has less embodied energy because the processes of iron ore extraction, transportation and raw material processing aren't present.

### Water

The flow of water begins with the ecological processes of evaporation,



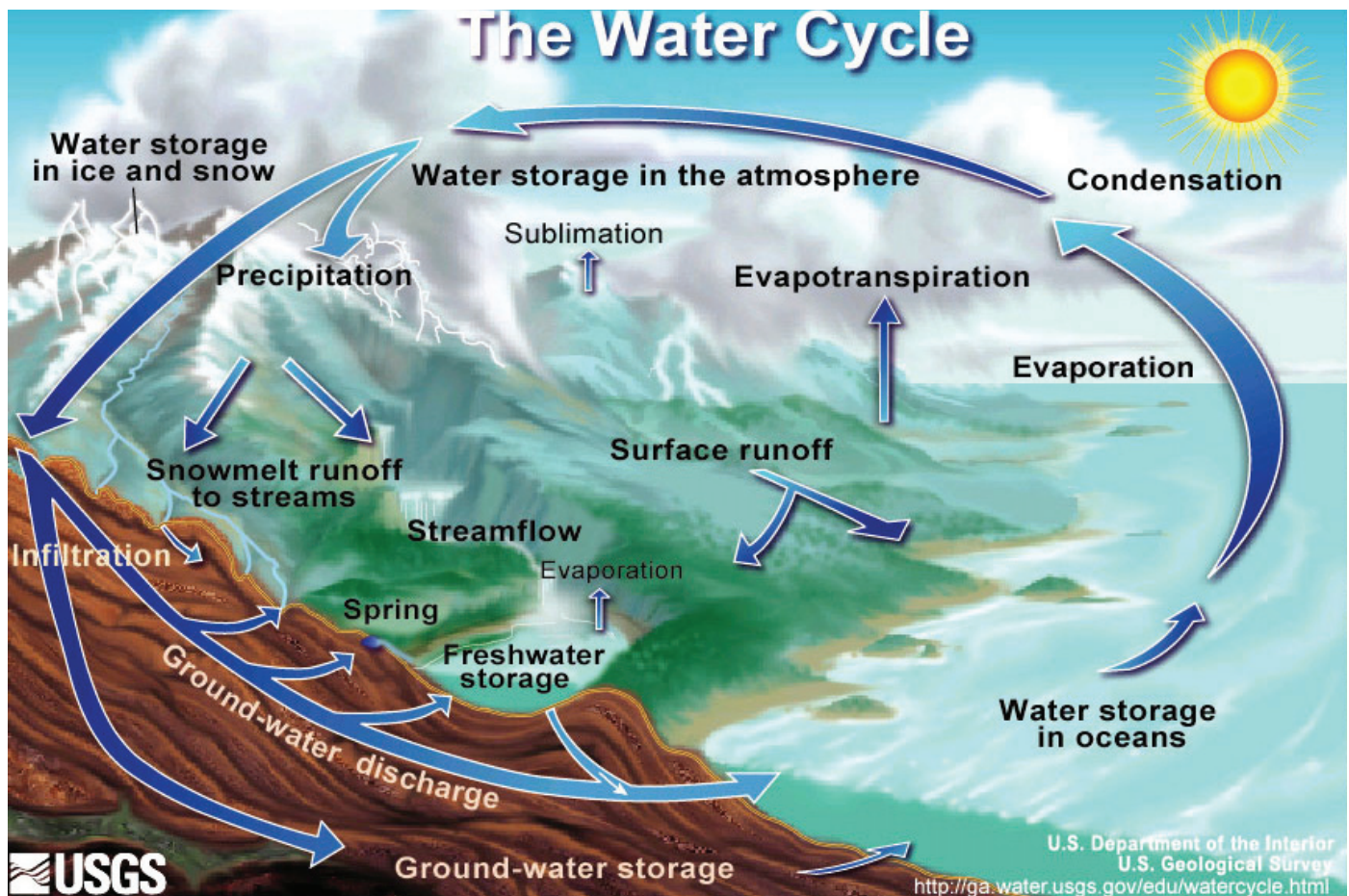


Fig. 03 The ecological flow of water

condensation, precipitation and infiltration. Once water has fallen in the form of precipitation, it is collected, treated and sent off to users for a wide range of different activities.

In a building, water is a key element from the beginning in the construction phase as it is used in making materials, such as mixing concrete. Once the building is occupiable, water is used for cleaning and other maintenance purposes as well as service purposes such as in restrooms.

Today, commercial toilets must use

no more than 1.6 gallons per flush while urinals must use no more than 1 gallon per flush. Multiply that number by the number of users, and one can see that a vast amount of water is needed just for this use.

In a building, there is high potential for water recycling through the use of gray water. In this process, solids and contaminants are removed and the water is treated and repurposed within the building to flush toilets and urinals, irrigation/landscape purposes and sometimes, running laundry washing machines. Rain water harvesting is a sustainable measure in which water

is collected from on or around a building. This water be collected in cisterns with little or no treatment for uses like landscape watering. There is a simple formula for calculating the amount of water a building could capture from the roof<sub>3</sub>:

$$G = 0.4 \times R \times A$$

G = gallon harvested (yearly)  
R = precipitation in inches (yearly)  
A = area of roof in square feet  
0.4 = collector efficiency coefficient

This formula could be used to calculate the amount of water use within a building that could be

supplemented by collected rainwater, thereby decreasing the need on a city's water system.

### Energy

To stay within the context of sustainability, an examination of renewable energy flows is most relevant. There are several varying forms of renewable energy, including solar, wind, rain, tidal, and geothermal. Energy is used during all stages of interaction with a building, including construction and destruction, but with building occupation responsible for the bulk of energy use. The flow of energy involves collection, storage, and use.

Solar energy is amongst the most readily available source for renewable energy. The total solar energy absorbed by Earth's atmosphere, oceans and land masses is approximately 3,850,000 exajoules per year, more energy in one hour than the world uses each year. Active solar techniques use photovoltaic panels, pumps, and fans to convert sunlight into useful energy. Storage of solar energy is essential because buildings need to use energy during hours when the sun is not present. There are many different techniques for storing solar energy. Thermal mass allows a building to store the heat produced by solar radiation in materials with a high specific heat (such as water, earth, and stone). Phase change materials such as paraffin wax and molten salts also allow solar energy to be stored at high temperatures. In PV systems, energy can be stored in rechargeable batteries or can be sent as electricity directly into the grid to offset electricity used when

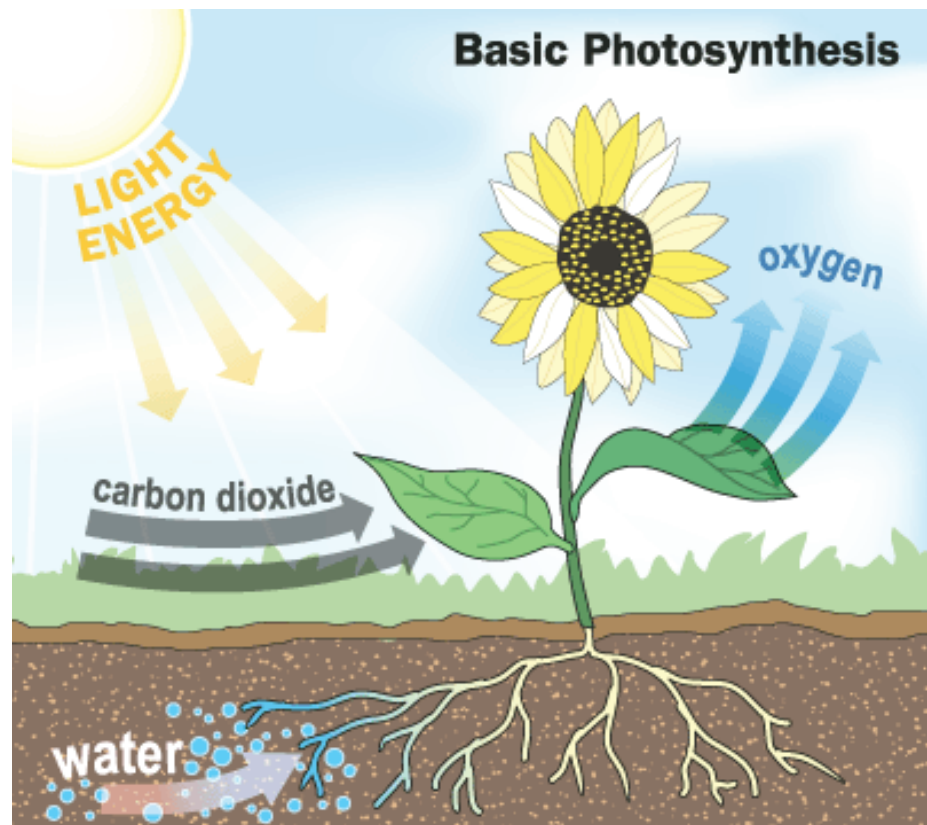


Fig. 04 Diagram showing photosynthesis

the system cannot meet demand. Other various forms of renewable energy have their own technologies that allow energy to be collected and stored.

### Organisms

This primary flow might be the most dynamic in that the life cycles of organisms, which for the purposes of this paper will be focused mainly on people and plants, respond to outside influences in a way other flows do not.

In relation to a building, one must keep in mind the way in which people are going to use the spaces and circulate between them. At

different stages in development, people are more or less capable of traversing certain distances or making level changes for example. The circulatory flow of a building is perhaps the most important aspect in design in that the building is ultimately going to be used by people and its success or failure can be gauged on the effectiveness of the circulatory design.

For vegetation, life processes are more straightforward. Seed germination produces a living plant which uses photosynthesis throughout its life cycle to survive. Plants, unlike people, are heavily influenced by seasonal changes. These changes can alter the spatial quality that plants create.



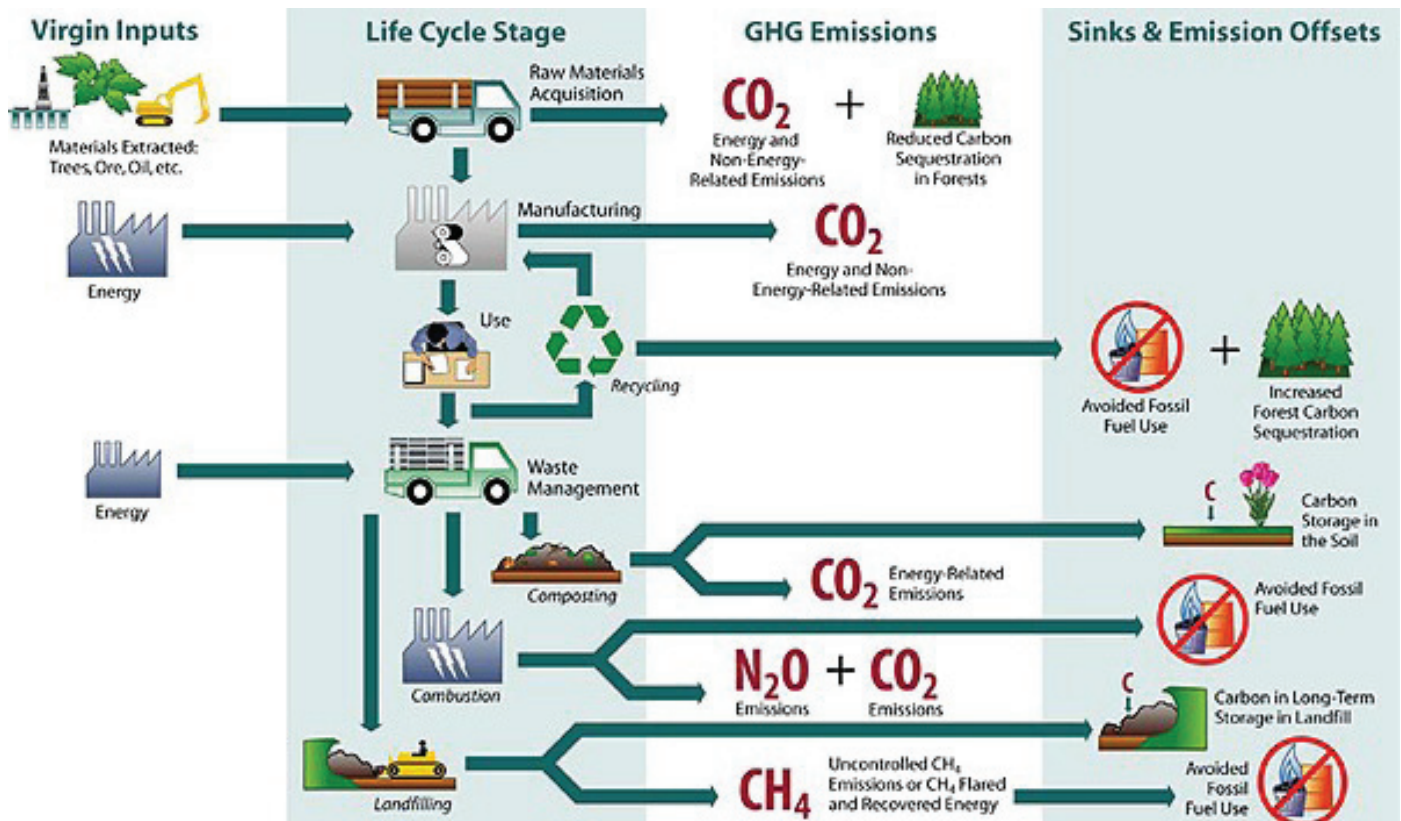


Fig. 05 Diagram showing the branching secondary flows from the primary flows

For example, in the summer, trees in a courtyard have all of their leaves, providing shade and cooler temperatures for the users of the courtyard. In the fall and winter, trees lose their leaves, allowing more sun to come in and warm the space as well as the users.

The flows of organisms can best be seen in relation to one another and to the life cycle of a building. The life cycle of people today is roughly 75 to 80 years while the life cycle of a building is more around 50 years or less. The life cycle of plants, based on seasonal changes and type is more in the area of less than a few years for smaller species and upwards of 100 years for large trees. These flows continue on their

own trajectory for most of the time, converging only for a limited period, in the grand scheme of time.

### Information

The flow of information is a less tangible topic but it is an essential part of the design and operational process of a building. There are four stages to the flow of information: data acquisition, data validation, data analysis, and data conversion. When designing a building, there is a process of research that must be done before designing can begin. This can include research of precedent buildings, reference to building codes and zoning laws, construction methods

and techniques, understanding sustainable technologies and importance of building orientation, or simply an understanding of spatial qualities. The amount of preliminary research and information that goes into the creation of a successful building is endless. Information can also be associated with the day-to-day operations of a building and as a way to evaluate the performance of a building.

### Secondary Flows

Secondary flows are the byproducts of certain processes and at the same time provide the necessary connections between the different parts of primary flows. Vehicles,

manufactured goods, waste, emissions and money act as catalysts in these events, providing the ways and means to connect primary flows within themselves and to other things.

Vehicles literally enable the transfer of goods and information throughout primary flows while money is the main reason behind everything. With these influences, manufactured goods as well as emissions and wastes are created. After the life cycle of a manufactured good is complete, the disposal of the good creates waste as well as possible emissions. For example, decomposing PVC emits harmful chemicals into the atmosphere and can have serious consequences for living organisms, be it people or plants.

Referring back to the iron ore example, the primary flow of iron ore from its raw material state to a finished steel beam involves many secondary flows along the way. First, iron ore is mined, which requires human involvement. These mining jobs have to be paid, so the flow of capital is present throughout the process. Iron ore has to be transported to a processing facility, involving more jobs, more capital and vehicles. The process of using ore to create pig iron and ultimately steel creates emissions and inevitably waste products which then need to be transported out of the processing facilities and either disposed of or used for alternate purposes.

### Cradle to Cradle

Since the Industrial Revolution, people have used earth's resources as though there was a never ending

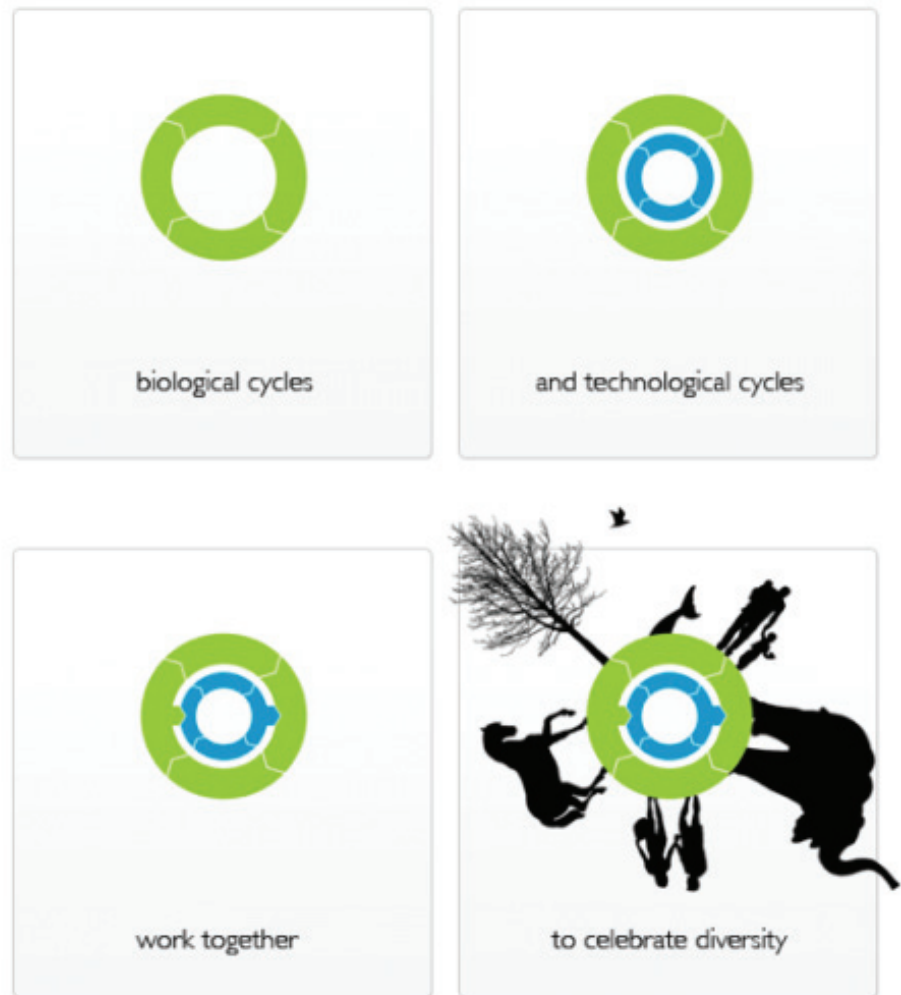


Fig. 06 Diagram showing the philosophy of Cradle to Cradle

supply, cultivating manufacturing processes that are extremely harmful to the environment. Products are generated that have a specifically engineered life cycle, rendering them useless in a short amount of time.

The authors of Cradle to Cradle, William McDonough and Michael Braungart, point out the flaws of this cradle-to-grave mindset and suggest a closer reflection of natural processes in designing and manufacturing products today.

The authors claim that recycling measures in place today mean being "less bad," prolonging a product's use by an additional life cycle, giving it a little more time before it ultimately ends up in a landfill. Recycled materials, they say, are of lower quality than the materials that were originally produced. In recycling plastic, for example, separating and melting down plastic products alters the properties of the fibers, making a recycled product of a lower caliber,



which could potentially off gas dangerous emissions.

In order to create more sustainable products, responsible and efficient design decisions need to be made. The design and production process needs to be questioned at each level to maintain quality control in the way of material usage and manufacturing practices. In order to achieve this goal, people of different disciplines need to work together. For example, William McDonough is an architect and Michael Braungart is a chemist. They met at a party during which they talked about sustainable practices and products. By coming together, each was able to lend ideas and opinions which when combined, created a holistic philosophy for sustainable design.

## Conclusion

It is important to acknowledge the presence of flows throughout the life of every building. Buildings are usually understood as static objects, but these underlying flows provide another dimension of understanding to buildings. As design guidelines become more and more conscious of sustainability, the importance of examining flows becomes more prevalent. Architects must recognize each individual component of each building as a process of existence. The flows of these individual parts tell the story of the building as a whole and it is not until these flows are appreciated that architecture can respond proficiently.

## Notes

1. Steel-Raw Materials

2. <http://www.wbdg.org/design/conservewater.php>

3. Rainwater Harvesting and Storage

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## Figures

Figure 01: From <http://www.isover.com/Our-commitment-to-sustainability/Toward-sustainable-buildings/What-is-sustainable-construction>

Figure 02: From <http://geoinfo.nmt.edu/resources/minerals/home.html>

Figure 03: From <http://www.theresilientearth.com/?q=content/more-water-vapor-woes-climate-modelers>

Figure 04: From <http://www.geographyalltheway.com/assets/error.htm>

Figure 05: From <http://www.epa.gov/climatechange/wycd/waste/lifecycle.html>

Figure 06: From <http://gijsbertkoren.wordpress.com/>

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